

## EFFECT OF LOCATION OF SEED UPON GERMINATION

EDWARD N. MUNNS

The influence of parent trees upon the size and germination of Jeffrey pine seeds has been shown in a previous paper.<sup>1</sup> The marked results obtained from that work resulted in the present study, in which it has been sought to determine the value of seeds from different parts of the pine cone; and to decide what relation, if any, exists between the position of the seed and germination. The cones used were collected from *Pinus Jeffreyi* trees on the eastern slope of the Sierras in Lassen County, California, in September 1919. No attempt was made to choose the trees from which the cones were taken, except that the trees were young and growing thriftily, considering the site upon which they stood.

The cones were grouped according to size in three divisions, based on the gross characteristics of length, breadth, and weight. They were dried slowly in a room at air temperature, and as they opened the seeds were extracted. The cones were divided into three sections of approximately equal size, to be known as the upper, middle, and lower portions. The seeds were carefully collected and graded into three classes, large, medium, and small, using ocular means of determining the size and comparing one seed with another. Inasmuch as a number of individuals helped to determine the size of the seed grains themselves, the individual variation from this source was very largely eliminated. The seeds were cleaned, counted, and weighed, each lot kept separately, and sufficient seeds to carry out the test taken at random from each lot. To determine the germination, a number of each lot of seeds were sown in cans containing a uniform depth of soil and covered by an approximately equal depth of sand in each case. As previous work has shown that for Jeffrey pine a soil moisture content of about 15 per cent gives the best results, frequent weighings were made to keep the moisture content of the samples a constant at this figure. The result of this study is presented in tables I-VII.

<sup>1</sup> MUNNS, E. N., Effect of fertilization in seed of Jeffrey pine. *Plant World* 22:4. 1919.

It was found that there was an increase in the number of seeds with an increase in the size of the cones, medium cones having 27 per cent more seeds than the smaller ones, and the large cones

TABLE I  
NUMBER AND WEIGHT OF SEED PER CONE

SIZE OF CONES	WEIGHT OF CONE (GM.)	NUMBER OF UNDEVELOPED SEEDS PER CONE	NUMBER OF DEVELOPED SEEDS PER CONE	WEIGHT OF DEVELOPED SEEDS IN CONE (GM.)	AVERAGE WEIGHT PER 100 SEEDS (GM.)						
					By portion of cone			By size of seed			Average for cone
					Upper	Middle	Lower	Large	Medium	Small	
Large.....	228.8	69.6	62.0	5.33	8.47	8.75	8.49	10.33	8.21	6.17	8.57
Medium.....	189.2	58.0	51.6	4.08	7.30	8.22	7.83	9.24	7.82	5.81	7.78
Small.....	145.7	37.3	38.9	2.66	6.42	7.18	7.68	7.83	6.49	6.19	7.09

TABLE II  
NUMBER OF SEEDS PER CONE BY SIZE OF SEED

SEEDS	LARGE CONES				MEDIUM CONES				SMALL CONES			
	Upper	Middle	Lower	Total	Upper	Middle	Lower	Total	Upper	Middle	Lower	Total
Undeveloped.....	28.7	22.2	18.7	69.6	25.5	16.9	15.9	58.3	13.0	14.5	19.7	47.2
Large.....	4.9	10.2	3.6	18.7	6.2	6.9	1.8	14.9	13.6	1.5	2.0	17.1
Medium.....	13.2	16.1	6.4	35.7	7.3	14.9	5.6	27.8	6.5	2.9	4.6	14.0
Small.....	3.3	2.0	2.3	7.6	2.0	5.1	1.8	8.9	3.6	3.0	1.9	8.5
Total developed seeds	21.4	28.3	12.3	62.0	15.5	26.9	9.2	51.6	23.7	7.4	8.5	39.6
Total.....				131.6				109.9				86.8

TABLE III  
PERCENTAGE OF SEEDS IN CONE BY LOCATION IN CONE

SEEDS	LARGE CONES				MEDIUM CONES				SMALL CONES			
	Upper	Middle	Lower	Total	Upper	Middle	Lower	Total	Upper	Middle	Lower	Total
Undeveloped.....	41.2	31.9	26.9	100	43.7	29.0	27.3	100	27.5	30.7	41.8	100
Large.....	26.2	54.5	19.3	100	41.6	46.3	12.1	100	79.5	8.8	11.7	100
Medium.....	37.0	45.1	17.9	100	26.3	53.6	20.1	100	46.4	20.7	32.9	100
Small.....	43.4	26.3	30.3	100	22.5	57.3	20.2	100	42.3	35.3	22.4	100
Total developed seeds	34.5	45.6	19.9	100	30.0	52.2	17.8	100	59.8	18.7	21.5	100

51 per cent more than the small cones. Another interesting thing was that there were more undeveloped seeds than developed, except in the case of the small cones, where there was a slight decrease. In the large cones 47.1 per cent of the seeds were fully developed,

in the medium cones 47.0 per cent, and in the small cones 54.2 per cent. In each cone it was found that there were twice as many large as small seeds, and more medium seeds than there were large and small seeds together, except in the small cones where there was a slight decrease.

The quantity of large seeds amounted to about 30 per cent of the total in the large and medium sized cones, and 43 per cent in the

TABLE IV  
PERCENTAGE OF SEEDS IN CONE BY DEVELOPMENT AND SIZE

SEEDS	LARGE CONES				MEDIUM CONES				SMALL CONES			
	Upper	Mid- dle	Lower	Aver- age	Upper	Mid- dle	Lower	Aver- age	Upper	Mid- dle	Lower	Aver- age
Developed.....	36.7	50.0	39.5	47.1	50.0	50.0	37.2	47.0	50.0	62.2	46.6	54.2
Undeveloped.....	63.3	50.0	60.5	52.9	50.0	50.0	62.8	53.0	50.0	37.8	53.4	45.7
Total.....	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
				Total				Total				Total
Large.....	7.9	16.5	5.8	30.2	12.0	13.4	3.5	28.9	34.4	3.8	5.0	43.2
Medium.....	21.3	26.0	10.3	57.6	14.1	28.9	10.8	53.8	16.4	7.3	11.6	35.3
Small.....	5.3	3.2	3.7	12.2	3.9	9.9	3.5	17.3	9.1	7.6	4.8	21.5
Total.....	34.5	45.7	19.8	100.0	30.0	52.2	17.8	100.0	59.9	18.7	21.4	100.0

TABLE V  
WEIGHT OF SEEDS IN GRAMS PER 100 SEEDS

SIZE OF SEED	LARGE CONES			MEDIUM CONES			SMALL CONES		
	Upper	Middle	Lower	Upper	Middle	Lower	Upper	Middle	Lower
Large.....	10.20	10.14	11.07	8.35	9.80	10.15	7.57	8.33	9.87
Medium.....	8.47	8.15	7.84	7.11	8.07	8.08	5.32	7.60	7.15
Small.....	5.92	6.41	6.31	4.81	6.37	5.30	4.20	6.20	5.43

small cones; medium seeds made more than 50 per cent of the total in the large and medium cones, and 35 per cent in the small cones; while the small seeds formed 12 to 17 per cent in the large and medium cones, and 21 per cent in the small cones.

The weight of seeds ranged from 4.20 to 11.07 gm. per hundred seeds, the average being 8.28 for large cones, 7.56 for medium cones, and 6.85 for the smallest. Using the smallest seeds as unity, the heaviest seeds in the small cones exceeded this by 135 per cent, the smallest in the medium cones was 14.5 per cent

heavier, while the largest was 141.7 per cent. The lightest seeds in the large cones exceeded the smallest seeds by 41 per cent, and the largest seeds were 164 per cent heavier than the smallest seeds.

Table VI shows that it is the size of seed rather than position in the cones which is the determining factor, there being a decided decline in the germination per cent with the size, while apparently no relation holds between position and germination. It has been shown that the weight of the seed is directly influenced by the

TABLE VI  
GERMINATION PER CENT BY SIZE OF SEED AND LOCATION

Material	Large cones	Medium cones	Small cones	Average
Large seed.....	66.9	58.1	55.2	60.1
Medium seed.....	51.9	52.4	35.4	46.6
Small seed.....	35.2	25.5	23.7	28.1
Upper cones.....	51.0	38.6	35.8	41.8
Middle cones.....	52.7	50.7	39.5	47.6
Lower cones.....	50.7	46.7	39.1	45.5
Average for cones.....	51.5	45.3	38.1	45.0

TABLE VII  
GERMINATION PER CENT BY WEIGHT OF 100 SEEDS IN GRAMS

Weight per 100 seeds	Germination per cent	Weight	Germination per cent	Weight	Germination per cent
4.0.....	17.5	7.0	40.5	10.0	64.5
5.0.....	24.5	8.0	48.5	11.0	72.5
6.0.....	32.5	9.0	56.5	12.0	80.5

size of cone, and this is further reflected in the germination. Charting the weight and germination, it was found that a straight line relation existed, which is expressed in table VII. A curious relation was shown in the rapidity of germination. Seeds from the lower portion of the cones completed half their germination five days sooner than seeds from the middle third of the cone, which in turn were five days earlier than seeds from the upper part of the cone. Apparently this was independent of the size of the seeds and varied with the size of the cone, the seeds from the larger cone being the more rapid. Final germination apparently did not conform to any regularity, except that the seeds from larger cones

completed their germination first, followed by the medium sized cone, the small cone seeds being last, with two weeks difference between the large and small cones.

These results have an immediate application in forestation work. So far as is known, little attention is being paid to the parentage or the condition of the seed before sowing. As pointed out previously, only seeds from thrifty trees should be used, and in the present study it appears that if it is impossible to collect only the largest cones in the field, a screening process is necessary to remove the small seeds and secure only those of large size. Studies under way show a relationship between the size of seeds and the early growth and establishment of forest tree seedlings similar to that given here, and it is believed that the "dominance" classes in the forest in a measure are an index of the size of the seed from which the tree originated. To secure the best possible forest, it is believed that forest nursery practice should be confined only to the production of trees from the heaviest and therefore largest seed.

FOREST SERVICE  
WASHINGTON, D.C.